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GROUND MOTION CHOICE IMPACT ON SEISMIC LOADING PARAMETERS ESTIMATION

ODHAD VLIVU VÝBĚRU SEISMICKÉHO POHYBU NA PARAMETRY SEISMICKÉHO ZATÍŽENÍ

Abstract

The determination of a realistic input motion applied at the structure base can be the most important step in the earthquake resistant structure design and may have a significant impact on the structure stability. For most horizontally layered sites lying on bedrock, a one-dimensional pure shear model can be used to calculate the free-field surface displacements of the earthquake motion, applied at the soil deposit as well as at the structure foundations base. The estimation of earthquake motions at the site of a structure is the most important phase of the resistant structure design in the structure dynamic analysis.

Introduction

The seismic structure loading accuracy and structure stability depends on the input motion choice applied at the structure foundation. All real structures have potentially an infinite number of displacements. Therefore, the most critical phase of a structural analysis is to create a computer model with that will be simulated the real structure behavior and computed the foundation soil deposits response to the base rock motion. The estimation of seismic input motions at the structure site is the most important phase of the resistant structure design in the dynamic analysis of the structure.

The computations analysis must be repeated for several different seismic motions to ensure that all frequencies are excited. The response spectrum for one seismic motion applied in a specified direction is not accepted. There are computational advantages in using the seismic response spectra methods analysis for relative displacements spectrum and relative velocities spectrum prediction in structural systems.

The stiffness structure properties can be approximated by high degree of confidence with the experimental, geotechnical data aid. However, the dynamic loading, energy dissipation properties and boundary conditions for many structures are difficult to estimate. This problem, with the determination of a realistic site-dependent ground motion at the bedrock and at the structure foundation, is the most important step in seismic structure loading and may always have a significant structure stability impact.

The free-field surface motion could be estimated and specified under the form of earthquake acceleration records in three directions at the location of the structure. It is now common practice several earthquake acceleration records different sets investigate on major engineering projects. In case of very massive and stiff structure the foundation which is relatively soft, the input motion at the structure base must be significantly different of the bedrock and free-field surface motion.

To reduce the impact caused by the approximations summarized in the previous text, it is necessary to apply different dynamic analyses using different computer models, different site-dependent seismic input motion and boundary conditions. Some of those methods to estimate the input ground motion choice applications impact on the computed seismic motion parameters such as relative displacements spectrum and relative velocities spectrum have been applied in this paper.

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Input motions setting impact

There are computational advantages in using the response spectrum computation method of seismic analysis for displacements and velocities prediction in structural system. This approach involves the maximum displacements and velocities values calculation of using several seismic input motions response spectra average.

The seismic motion parameters in this paper represent the displacements response spectrum and the relative velocities spectrum, computed at some structure points with several seismic input motion time histories applied at bedrock and at the structure foundations. The recent speed computers increase will run of many time histories analyses in a short time.

The different computed geotechnical models subjected to numerous input base seismic motions were analyzed for the three - dimensional structure dynamic behavior estimation and their dependence on displacement and velocity response spectra. The computing program Flush, using a direct step-by-step integration method in which the nonlinear equations of motion are solved, was applied for that purpose.

Results analysis

It is apparent that all response spectra curves represent the different seismic parameters at a specific structure sites, are not the structural system properties function. After structure behavior estimation analysis made on the different damping and geotechnical structure basement properties, a specific response spectrua displacement and velocity curves were selected (Figures).

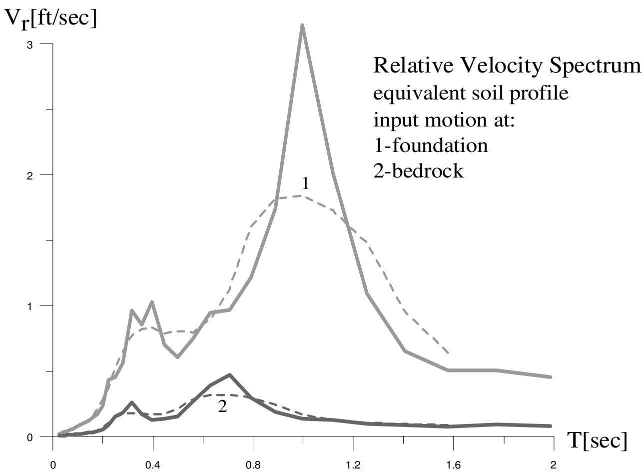

figure 1

The curves shown in Figure 1 define the different foundations (1) and bedrock (2) seismic input motion computed relative velocity spectrum. There is a mathematical relationship between the relative and total-velocity spectrum. The values and frequency shift for both equivalent soil profile and applied input motion is obvious on Figure 1.

The maximum ground acceleration defined by computed earthquake ground acceleration time histories (PGA) represent the same value that the pseudo-acceleration spectrum for a very short period. The reason is the physical fact that a very rigid structure moves as a rigid body and the relative displacements within such structures (as indicated on Figure 2 and 3), are equal to zero for a very short period (Wilson, E.L., 2002),.

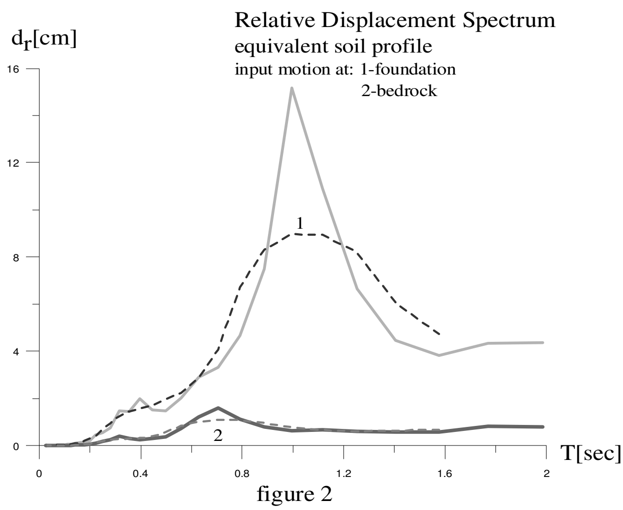

figure 2

Therefore, the relative displacement spectra curves shown on Figure 2 will converge to 15.6 cm at a period of 0.9 seconds for 5 percent of

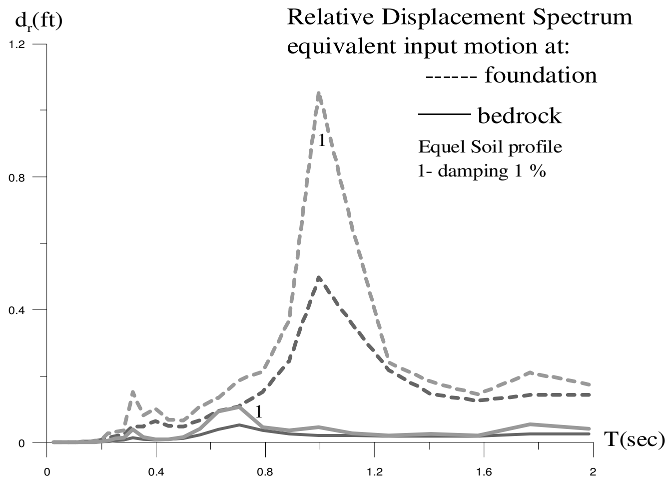

figure 3

damping and 30.2 cm at a period of 1.0 second for 1 percent of damping. However, the maximum relative displacement is directly proportional to the maximum forces developed in the structure. The structure peak velocity of 12,5 cm/sec is considered as a serious for certain structure design. It is important to note the significant value differences between 1 and 5 percent damping for this site record.

The curves depicted on Figure 3 represent relative displacement spectra for different damping values of 5 and 1 percent (1). Both, soil profile and input motion for solving damping values being equal. The dotted structure and ground surface motions characteristics computed as a response spectrum lines correspond to the structure foundation input motion setting on Figure 3. The full computed spectra lines correspond to the bedrock input motion setting at the same figure. The displacement spectra differences corresponding to the input motion settings as well as to the damping values are strong. The underlying sedimentary rock formation damping and transfer properties influence within soil deposits is evident and significant (full lines on Figure 3), on the computed relative displacement spectra.

The curves set on Figure 4 represent relative displacement response spectra for equivalent soil profile, different damping values of 5 and 1 percents and for the different input motion too. The variant input motions influence for soil profile equivalent maintenance is evident. Therefore, the realistic input motion choice and setting is the most important step in the seismic structure loading analysis and have always a significant structure stability impact.

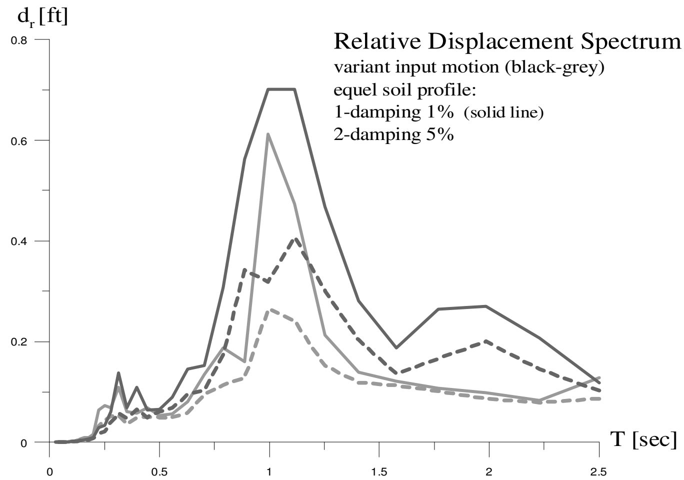

figure 4

Conclusion

The seismic structure loading accuracy and structure stability depends on the seismic input motion choice applied at the structure foundation. The earthquake motions estimation at the structure site is the most important phase of the structure design in the dynamic analysis of the structure.

Computed and presented both relative velocity and displacement response spectra variability for equivalent and variant geotechnical properties soil profiles, variant input motions settings and the various damping ratio presented in this paper, constitute very interesting features in comparison with their engineering practice applications.

The displacement spectra differences corresponding to the seismic input motion settings as well as to the damping values, are strong. The input motions determination and setting choice is very important structure dynamic analysis approach with the design and seismic loading stability scope. So, the various relative velocity and relative displacement values and their large-scale differences due to the mistaken input motion setting option can simulate the unreal structure behavior prediction with significant economic and structure design and stability impact.

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Literatúra

[59] Kaláb, Z., Gruntorád G.(1992): Spectral analysis of short seismic signals. Acta Montana, series A, No 2(88), p.91-98.

[60] Leššo, I., Flegner, P., Pandula, B.(2004): Application analysis in geotechnics, Transactions of VŠB-Technical University, 2, Roč. IV, pp.183-188, Ostrava.

[61] Lysmer, J., Udaka, T., Tsai, C.F., Seed, H.B. (1990): FLUSH a computer program for approximate 3-D analysis of soil-structure interaction problems. UCB/EERC-75/30, Berkeley: Earthquake Engineering Research Center, University of California.

[62] Kuževič, Š., Pandula, B., Kuževičová, Ž., (2004): Priestorová analýza porušenosti horninového prostredia, Transactions of VŠB-Technical University, 2, Roč. IV, pp.183-188, Ostrava.

[63] Viskup, J.(2003): Modelovanie seizmickej odozvy pomocou waveletov, Sborník vedeckých prací Vysoké školy báňské-Technické Univerzity Ostrava, řada stavební,Ročník III, č.2, pp.259-265, VŠB-TU Ostrava.